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ABSTRACT

A growing body of evidence indicates that activity-based approaches to teaching science are more effective than traditional methods in producing a wide range of desirable student outcomes at all grade levels. The Elementary Science Education Institute (ESEI) was designed to train elementary science teachers in the use of hands-on science methodology. From 1987 to 1989, 27 teams of 4 educators each completed 240 hours of instruction at the University of Tennessee at Martin, followed by a year-long program of science education improvement at their schools. Data on content knowledge and attitudes were collected from 902 students of teachers in the first cycle of training and a comparison group of students whose teachers did not participate in training. After one year of instruction, ESEI students outperformed controls on content knowledge for Grades 1, 2, 4, 5, and 6, although fifth grade differences were not significant. For first and second grades, attitudes toward science instruction (as measured by forced-choice questions) improved during the year among ESEI students but became more negative among controls. However, attitudes indicated by open-ended affective questions became more negative for both groups. In Grades 4-6, while attitudes on both types of questions became more negative for both groups, ESEI students had better attitudes than the comparison group in fourth and sixth grade, and controls had better attitudes in fifth grade. (SV)

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Hands-on Science Instruction in the Rural Elementary School: A Strategy to Reduce the High School Dropout Rate

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HANDS-ON SCIENCE INSTRUCTION IN THE RURAL ELEMENTARY SCHOOL: A STRATEGY TO REDUCE THE HIGH SCHOOL DROPOUT RATE

Introduction

Some of the well documented factors that put students "at risk" are poverty, ethnic or racial origin, and dysfunctional family life. However, "[in] much of the literature on children-at-risk 'squeeze out,' 'push-out,' and 'left out' appear routinely along with 'dropout.' . . . These terms suggest that the school is often an unwitting accomplice in the process of a student's dropping out of school." (Brodinsky, 1989, p.13). It has been shown that students with a low SES background tend to drop out at higher rates than those from higher SES backgrounds (Orr, 1987). When asked why they are leaving school students' reasons often reduce down to the fact that they do not have much success in school and they do not like it. But why? When did these attitudes begin? How has the school been an accomplice in this decision?

Family background is a powerful predictor of dropout behavior (Rumberger, 1983). In fact, after controlling for family background, race is not even a variable that predicts dropout behavior (Wehlage & Rutter, 1986, 87). Students from single parent homes, low income families, or whose parents were themselves dropouts often enter school at a disadvantage compared to other students whose pre-school background may have been more conducive to intellectual development. "As a result of early home and community influences, potential dropouts, at the time of school entrance, will have learned many things but very few that the schools will reward (Beck & Muria, 1980). Teachers perceive these students as being deficient in terms of vocabulary, acceptable use of English, and familiarity with numbers and the alphabet. In order to find ways of managing already heterogeneous classes, teachers begin to divide students into groups of similar abilities. What often happens (DeRidder, 1988) is that

groups with students having similar socioeconomic backgrounds, attitudes, values, and speech patterns are formed in the classroom. Although this grouping approach in kindergarten and first grade does allow the teacher to respond to students with similar levels of learning readiness, too often the less academically-ready are neglected. Unless there is periodic reshuffling, based on achievement, the groups remain intact and these students may be viewed as immature and are possibly retained in one of these early grades. At this point the dropout syndrome has begun. Low grades and retention are highly significant predictors of eventual dropping out, even as early as first grade (Magill, 1964). The Rosenthal effect, which says that the disproportionately low teacher expectation of the potential dropout will become a self-fulfilling prophecy, can clearly be seen by third grade. Lloyd (1978) went even further and proposed that almost 70% of the high school drop-outs can be predicted from data in the third grade based on four factors: 1) the student's achievement record, 2) socioeconomic status, 3) family characteristics, and 4) nonpromotion.

In recent years some researchers (Ekstrom et al., 1986; Wehlage & Rutter, 1986, 87; Mann, 1987; and DeRidder, 1988) have become convinced that rather than concentrating on programs to dissuade middle school and high school students from dropping out, action should be taken, first, to address the factors that the public school do control and, second, to do it early, long before students enter the dropout years. . Mann (1987) put it this way: **"The best way to avoid dropping out of high school is to make the elementary school more successful. . . The earlier we start, the less damage and greater the dividends."** (p. 318). The poor self-image and negative feelings about self and school should be addressed in the elementary years rather than treated during the high school years.

It is not surprising that a Vancouver, Washington study (Brodinsky, 1989) found that bad feelings about one's self negatively impact the learning ability of young people. It was noted that children who have not experienced success in a particular

type of learning environment and have internalized the fear of looking bad to others are not going to learn and will probably fail one of the early grades. Unless they have experienced success early in their school life, most will not stay in school, especially since being retained one grade increases their risk of dropping out by 40 to 50 percent. (Brodinsky, 1989, p. 2).

Kramer (1970) , in a case study, cited teaching methods that were dull, where the curriculum consisted primarily of copying and memorizing long list of words and phrases, and, yes, where dropouts were numerous. However, this is not a description of your neighborhood school here in the 1990s; it is a description of the schools set up by the Sumerians who established the first civilization about 5000 B.C. Whether it is 5000 B.C. or 1990 A.D., the major contention of this paper is that emphasis on memorization, recitation, and other passive forms of instruction contributes greatly to the negative attitudes that many children form toward school and that these attitudes may eventually manifest themselves in dropout behavior later on.

Are there then instructional strategies that teachers could use, from kindergarten on, which might lessen negative feelings that potential dropouts experience in elementary school? Extensive research into the use of activity-based science instruction in the post-Sputnik {1958} curricula has yielded much useful information concerning the effectiveness of this "hands-on" instructional approach. "The accumulating evidence on the science curriculum reform efforts of the past two or three decades consistently suggests that more activity-based approaches to teaching science result in gains over traditional methods in a wide range of student outcomes at all grade levels " (Bredderman, 1983, p. 513). The conclusions of a large meta-analysis project where 105 experimental studies on 45,000 students involving 27 different innovative science curricula, were summarized in the following way: "Across all new science curricula analyzed, students exposed to new science curricula performed better than students in traditional courses in general achievement, analytic

skills, process skills, and related skills (reading, mathematics, social studies, and communication), and were **developing a more positive attitude toward science. . .**" (Shymansky, Kyle & Alport, 1983, p. 387).

The ESEI Program

It is around this body of research that an Elementary Science Education Institute (ESEI) was designed, to increase the expertise of elementary science teachers in their use of a "hands-on-science" methodology and to thereby provide better opportunities for their students to grow cognitively and affectively. To promote and provide the training necessary to implement the ESEI, four member teams of local educators were recruited from nine school districts in each of three years, 1987, 1988, and 1989 (a total of 27 teams). A team consisted of a K-3 teacher, a 4-6 teacher, their building principal, and the system supervisor of instruction. Each team participated in a program of approximately 240 hours of instruction at the University of Tennessee at Martin, followed by a year-long program of science education improvement back in its local school. The Institute provided for the participants instruction in science content, principles of adult education which were used by the team members to propagate the techniques learned in the Institute to other schools, and instruction and practice in teaching science utilizing a "hands-on" methodology.

Data were collected from 902 students in the first cycle of the ESEI, 157 first graders, 254 second graders, 200 fourth graders, 143 fifth graders, and 148 sixth graders. These students were analyzed in two separate substudies, the first consisting of the first and second graders, and the second consisting of the fourth, fifth, and sixth graders. Two separate sets of instruments (a content instrument and an attitude instrument) were employed. In both studies students having ESEI teachers were compared with students not having ESEI teachers. After one year of instruction there was a significant gain ($p < .01$) in the content knowledge by both the first and second

grade groups of students and the ESEI students consistently performed better than the COMPARISON students (Hartshorn & Prather, 1990). In both the fourth and sixth grades, the ESEI students outperformed the COMPARISON group at the end of the year ($p < .01$) even though there was no significant difference between the two at the beginning of the year. At the beginning of the year the fifth grade COMPARISON group scored higher than the ESEI group, but at the end of the year results were reversed, with the ESEI group scoring higher than the COMPARISON group. However, neither of these fifth grade comparisons was statistically significant. The general conclusion was that, indeed, the ESEI students of this study reinforce the Bredderman and Shymansky et al. reports that indicated that there is a positive relationship between "hands-on" science instruction and achievement.

Do the attitude data collected in this study, as Shymansky et al. indicated, "[develop] a more positive attitude toward science?" The evaluation instruments utilized to provide this information about student attitudes towards their science instruction consisted of two parts. Part I consisted of forced-choice responses to 12 specific items associated with various individual aspects of science instruction. Part II consisted of more affective responses dealing with how the students felt about the instruction, and, in large part, these items were open-ended which allowed the students to express their feelings in their own way. These open-ended items were coded by designating each response as negative, neutral, or positive with regard to how well it correlated to supporting a "hands-on" instructional methodology.

To assure that the interrater reliability of the two raters was high, a training session for rating the responses was carried out. Responses from classes of students not utilized in this study were evaluated by both raters and designated as (-), (0), or (+). The raters then exchanged papers and once again evaluated the responses. A comparison of the two sets of ratings was made and discussion about disagreements was carried out. A guide was developed to detail the criteria for sorting various

answers into one of the three categories and was used in making decisions on subsequent papers. This process was repeated until greater than 90% agreement was consistently reached on new sets of papers. Only after this level of agreement had been reached were the papers of the students involved in this studied evaluated.

Analysis of the K-3 Study

The data were treated in the following manner. Two summated scales were computed, the first consisted of the responses to items 1-12 and the second consisted of the responses to items 13-15. These summated scores were computed for both the ESEI students and the COMPARISON group of students for both the pretest and posttest administrations of the attitude instrument. They are presented

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Insert Table 1 About Here

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in Table 1. In both the first and second grades, the ESEI group registered a more favorable attitude with regard to the the Part I questions at the end of the year compared to the beginning, while the COMPARISON group registered a more negative rating at the close of the year when compared to the beginning of the year. Both groups' ratings became less favorable in Part II as the year went on, however.

In addition to comparing the mean values of the summated scores, the mean value for each question was compared for both ESEI students and the COMPARISON group of students on both the pretest and posttest administrations of the attitude instrument. Of particular interest were questions #6, and #14. In both the first and second grades, question #14 that dealt with how the students felt when it was time for science, there was no significant difference between the ESEI and COMPARISON groups at the beginning of the year. However, at the end of the year the ESEI group had retained their favorable attitude, while there was a general decline in the

COMPARISON groups' attitude. In response to question #6 the ESEI first graders registered a significantly more favorable response to the way science was being taught than did the COMPARISON group at the end of the year, while there was no significant difference between their responses at the beginning of the year. The ESEI second graders responded significantly more favorable than the COMPARISON group at both the beginning and the end of the year.

Analysis of the 4-6 Study

The data from grades four, five, and six were treated in a similar manner to those in the K-3 study. Two summated scales were computed; the first consisted of the responses to items 1-12 and the second consisted of the responses to items 13-20. These summated scores were computed for both the ESEI students and the COMPARISON group of students for both the pretest and posttest administrations of the attitude instrument and are presented in Table 2. A review of the literature shows that attitude

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Insert Table 2 About Here

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measures consistently detect a decline in positive attitude as age of the students increases as well as from the beginning of the school year to the end. Yager et al. (1984) stated that, "Science classes are perceived as less 'fun' the longer the students remain in school (p. 40). Cannon and Simpson (1985) reported that middle school students lose interest in science as the school year progresses. Baker (1985) reported that even students with grades of A and B had negative attitudes toward science later in the school year. In a general way, these trends are reflected in the data collected in this study. In all three grades and for both the ESEI and COMPARISON students, there was a decline in attitude score on Parts I and II from the beginning to

the end of the year. However, the predicted descending trend from fourth to sixth grade was less clear.

The fourth grade ESEI group had a significantly higher mean attitude score on both parts of the attitude measure at the end of the year than did the COMPARISON group (note: on Part II the ESEI group started out significantly higher than the COMPARISON group at the beginning of the year). Of particular interest in the 4-6 study were questions #1, #6, and #14. The ESEI group showed a significant gain from the beginning of the year to the end in their response to question #1 which inquired about them liking to learn about science in school. Both the ESEI and COMPARISON groups had less favorable opinions about how science was taught at the end of the year (Question #6), but the ESEI group was significantly more favorable than the COMPARISON group at the end (there was no significant difference between the two at the beginning of the year). Finally, in responding to question #14 about how students felt when it was time for science class, once again both groups had less favorable opinions at the end of the year, but the ESEI students were significantly more favorable than the COMPARISON students.

The fifth grade was the only grade out of the five studied where mean scores for both parts of the attitude measure consistently favored the COMPARISON group in both pretest and posttest scores. The COMPARISON group began the year with higher mean scores (significantly higher for Part II) and retained their position in posttest scores with the COMPARISON group's Part I posttest scores becoming significantly higher than the ESEI group's. It is noteworthy that both the ESEI group and the COMPARISON group demonstrated an increase from pretest to posttest scores for question #1 where they were asked if they liked to learn about science in school.

The data from the sixth grade groups followed the trends found in the Cannon and Simpson (1985) study where students' attitudes tended to decline from the

beginning of the school year to the end. The summated scores for both parts of the attitude measure declined from pretest to posttest for the sixth grade ESEI group and the COMPARISON group. Even though the ESEI group had higher pretest scores than the COMPARISON group, the difference was not significant. However, the ESEI posttest means were significantly higher than those of the COMPARISON group. There was no significant difference between the mean scores of the ESEI group and the COMPARISON group for question #1 (Do you like to learn about science?) in the pretest or the posttest data. The means of both groups for question #1 increased with the COMPARISON group demonstrating a statistically significant gain. In response to question #6 (Do you like the way you are taught science?), the ESEI had higher mean scores for both pretest and posttest. For question #14 where students were asked how they felt when it was time for science class to begin, the ESEI group demonstrated a significantly higher response than the COMPARISON group at the end, whereas they were significantly lower than the COMPARISON group at the beginning of the school year.

Conclusion

The one area of a potential dropout's life over which the school has the most influence is that of the classroom experience. It is only logical that schools should try to provide the maximum opportunity for success in the classroom for all students, especially during those important "first impression" years of grade school. As persons practicing preventive medicine begin treatment before a condition develops, schools should take measures to help prevent students from dropping out before the symptoms appear. Where students are not interacting but only listening to or observing a teacher presentation there are higher absentee rates (Neill, 1979). Students who are chronically absent often fall behind their classmates and have been shown to drop out more readily than those who are consistent in school attendance (Neill, 1979). The

exploratory premise of this paper has been that activity-science and "hands-on" instruction tend to slow down or restrict the erosion of favorable attitudes toward science in particular and toward school in general. Data from both of the studies discussed in this paper reinforce this premise. At this point in time there is no direct evidence that maintaining better attitudes can lower future dropout rates. However, by promoting these positive types of feelings, the school may become a desirable place to be by students who may otherwise find it undesirable. As one fourth grade ESEI student put it, "Science class makes me want to come to school."

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Table 1
Comparison of the Mean Pretest and Posttest Scores for ESEI and COMPARISON Students on Parts I and II of an Attitude Measure of Science Instruction for Grades 1 and 2

Grade 1

	MEAN* (I)		MEAN** (II)	
	ESEI	COMPARISON	ESEI	COMPARISON
PRETEST	24.57	26.14	12.16	11.79
POSTTEST	26.21	24.67	11.52	10.61

Note: * Largest possible value = 36.00; ** Largest possible value = 15.00

Grade 2

	MEAN* (I)		MEAN** (II)	
	ESEI	COMPARISON	ESEI	COMPARISON
PRETEST	24.96	24.08	11.55	11.12
POSTTEST	25.39	23.00	11.19	10.34

Note: * Largest possible value = 36.00; ** Largest possible value = 15.00

Table 2
Comparison of the Mean Pretest and Posttest Scores for ESEI and COMPARISON Students on Parts I and II of an Attitude Measure of Science Instruction for Grades 4, 5 and 6

Grade 4

	MEAN* (I)		MEAN** (II)	
	ESEI	COMPARISON	ESEI	COMPARISON
PRETEST	34.65	34.98	21.65	18.98
POSTTEST	31.51	28.84	17.75	16.26

Note: * Largest possible value = 48.00; ** Largest possible value = 24.00

Grade 5

	MEAN* (I)		MEAN** (II)	
	ESEI	COMPARISON	ESEI	COMPARISON
PRETEST	35.43	36.84	21.68	24.47
POSTTEST	30.09	32.04	17.34	18.44

Note: * Largest possible value = 48.00; ** Largest possible value = 24.00

Grade 6

	MEAN (I)		MEAN** (II)	
	ESEI	COMPARISON	ESEI	COMPARISON
PRETEST	36.30	35.32	22.56	22.62
POSTTEST	31.06	30.00	18.68	17.38

Note: * Largest possible value = 48.00; ** Largest possible value = 24.00